United States Patent

[11] 3,577,882

[72] Inventor **Daniel L. Lombard**
Youngstown, Ohio

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[73] Assignee **Lombard Corporation**
Youngstown, Ohio

[54] **HYDRAULIC FORGING PRESS**
7 Claims, 21 Drawing Figs.

[52] **U.S. Cl.** **72/450,**
72/453, 72/455, 100/233, 100/271
[51] **Int. Cl.** **B21j 9/02**
[50] **Field of Search** 72/450,
452, 453, 455; 100/271, 293, 233

[56] **References Cited**

UNITED STATES PATENTS

844,751	2/1907	Robinson	100/293
902,652	11/1908	Greenleaf	72/452
1,823,430	9/1931	Rabezzana	29/33
1,945,879	2/1934	Burger	100/272
526,606	9/1894	Beche	72/450
765,020	7/1904	Leonhardt	72/450
1,639,459	8/1927	Knochl	72/450
2,558,071	6/1951	Castle	100/271
3,051,078	8/1962	Webster	100/271
3,253,440	5/1966	Baker	72/453

FOREIGN PATENTS

482,226	4/1952	Canada	100/272
598,479	9/1925	France	100/271

Primary Examiner—Charles W. Lanham
Assistant Examiner—Gene P. Crosby
Attorney—Murray and Linkhauer

ABSTRACT: This patent discloses novel forgoing presses of large capacity in relation to the weight of the press. According to the invention, such presses are made by applying force, preferably hydraulically, to a long lever arm and causing a shorter lever arm to apply an accordingly multiplied force to the work. With presses of the invention, total press capacities as large as any hitherto ever designed or contemplated may be obtained. In accordance with a preferred embodiment, there is obtained a relatively unmassive and inexpensive ultra high capacity press having a working surface open on three sides.

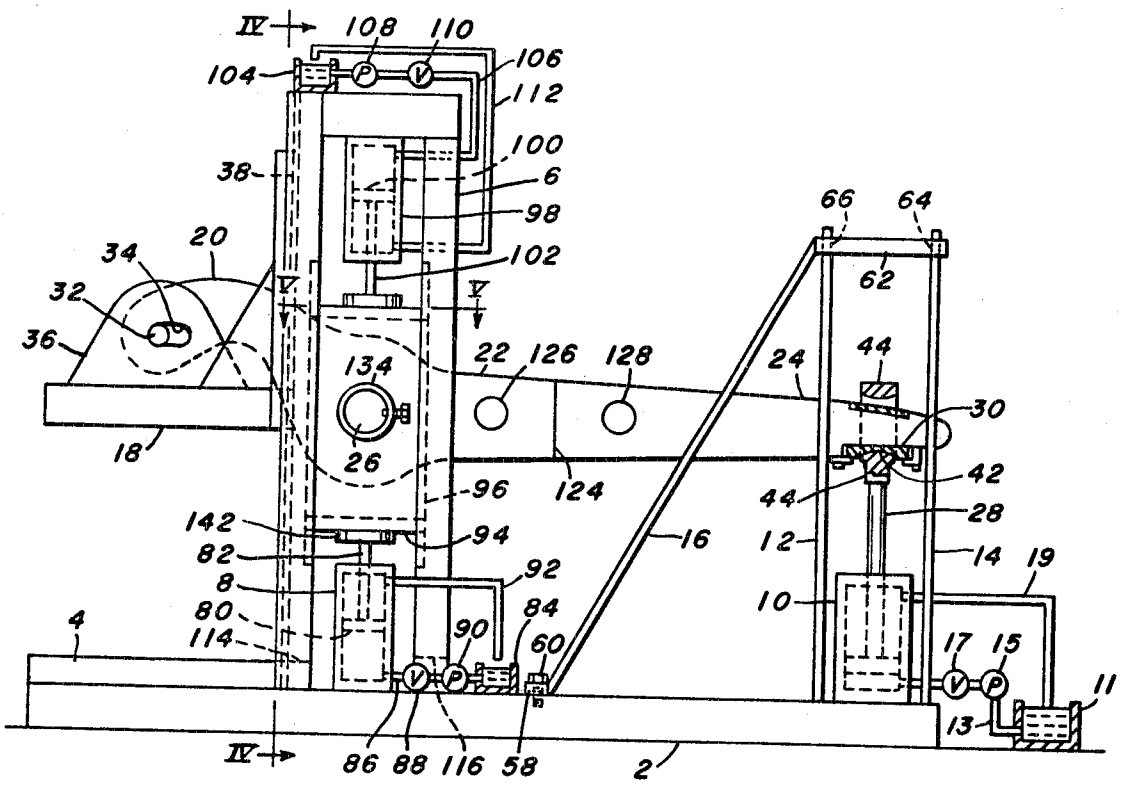

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FIG. 2.

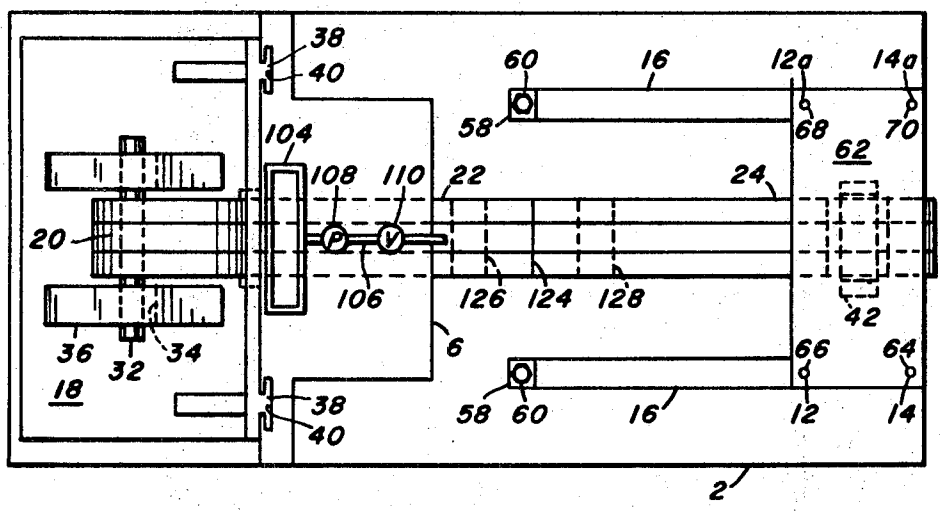
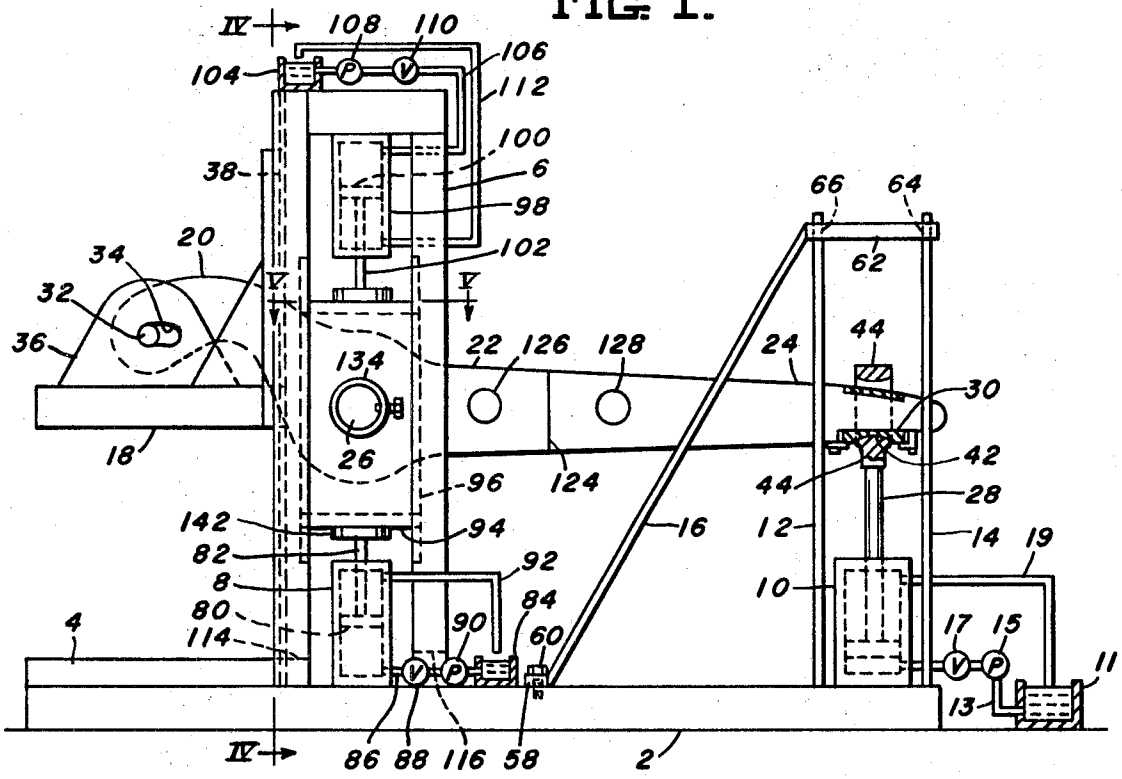


FIG. 1.



INVENTOR.
DANIEL L. LOMBARD

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Murray & Linklaver

Attorneys

FIG. 5.

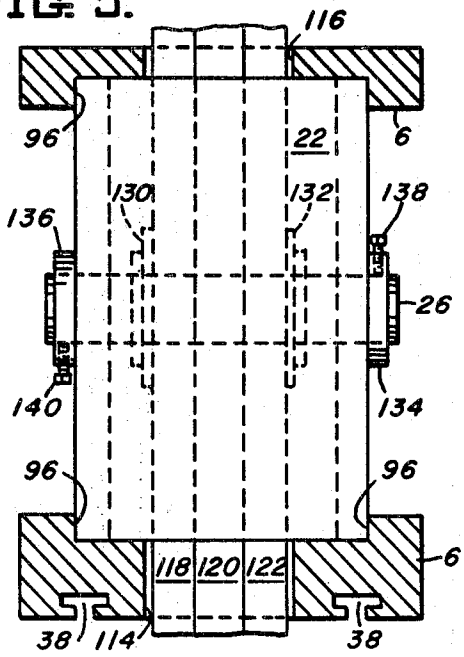


FIG. 8.

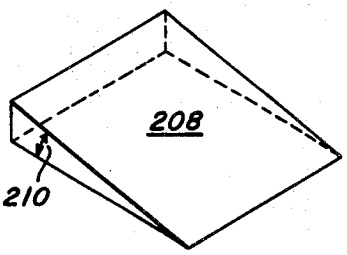


FIG. 4.

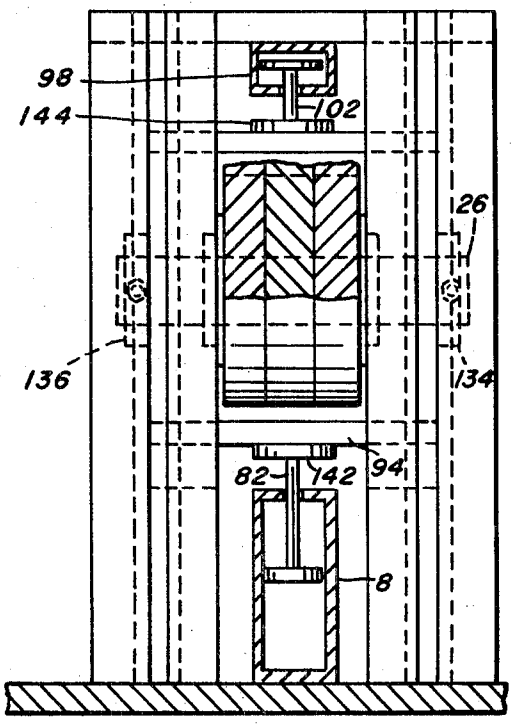
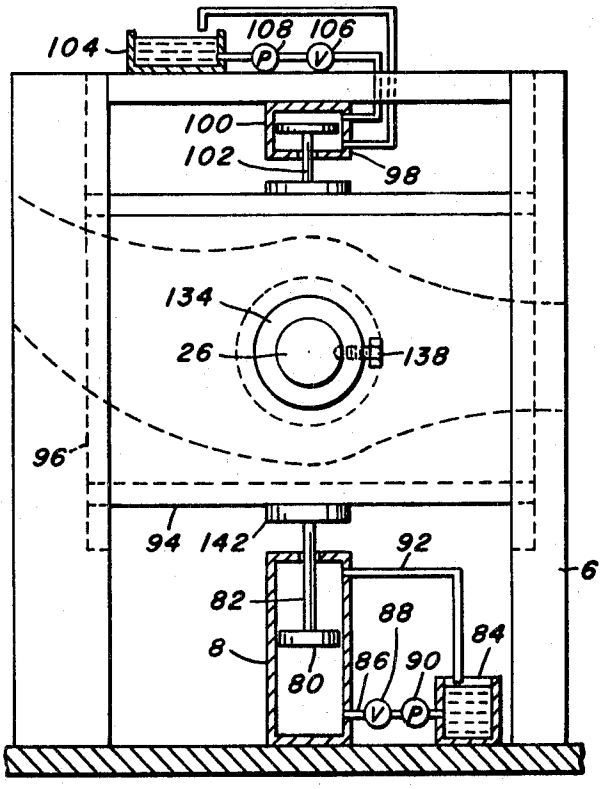


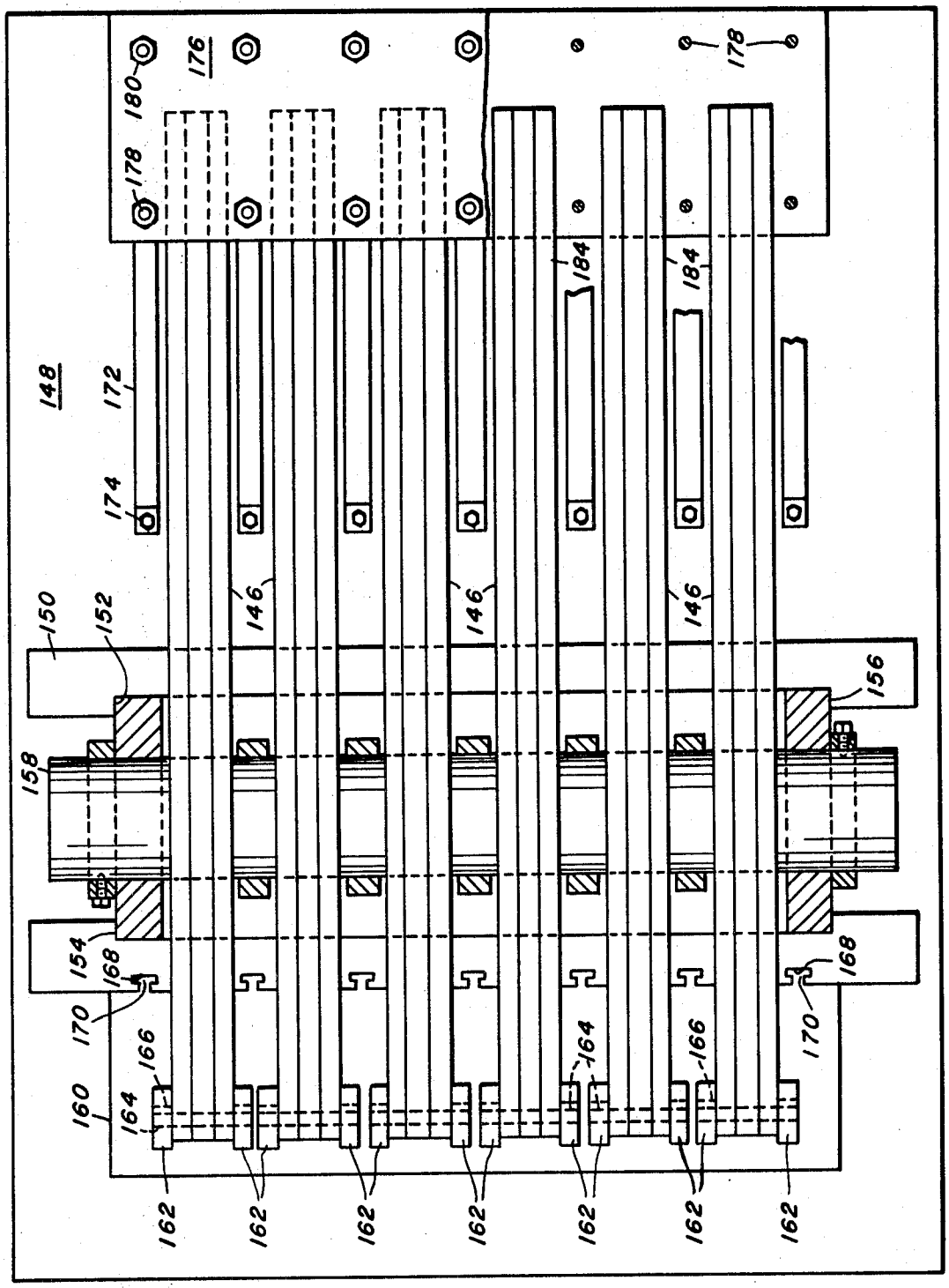
FIG. 3.



INVENTOR.
DANIEL L. LOMBARD

By
Murray & Finkhauser
Attorneys

FIG. 6.



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DANIEL L. LOMBARD
By
Murray & Linkhauer
Attorneys

FIG. 7.

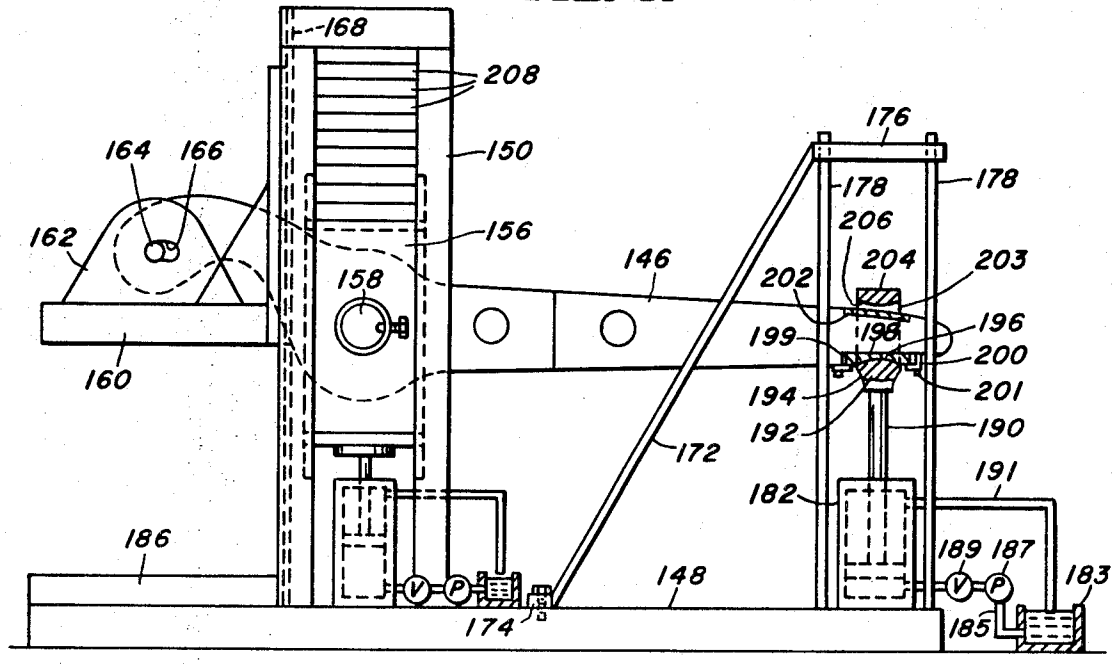
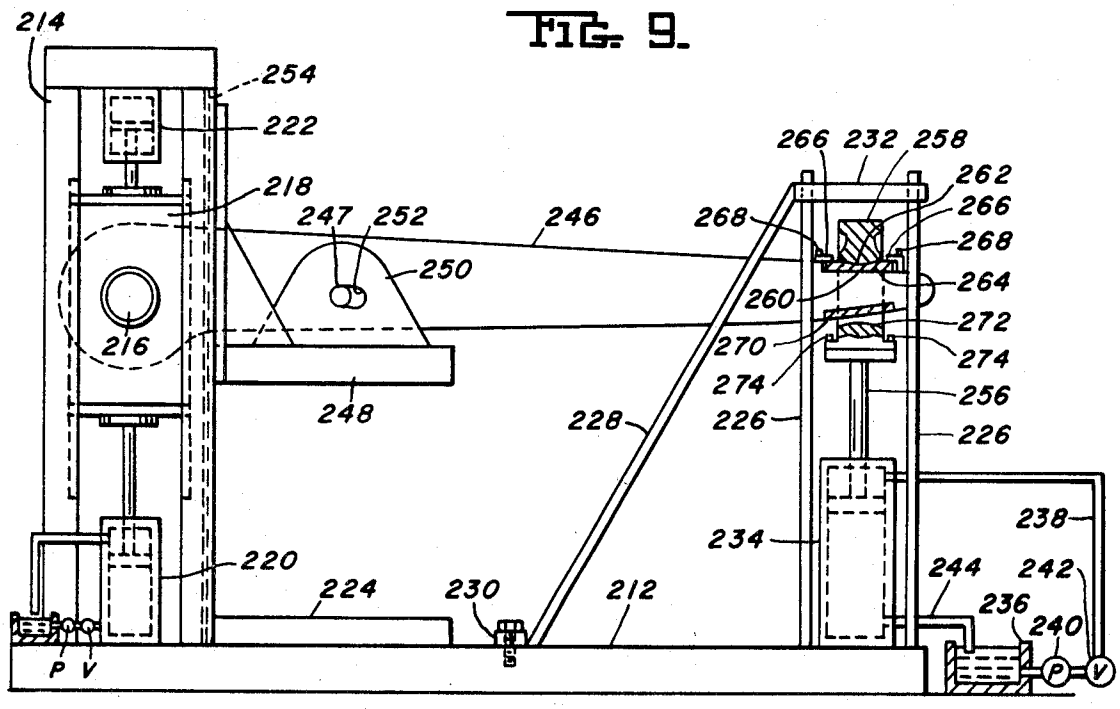


FIG. 9.



INVENTOR.
DANIEL L. LOMBARD
By
Murray & Linkhauer
Attorneys

FIG. 10.

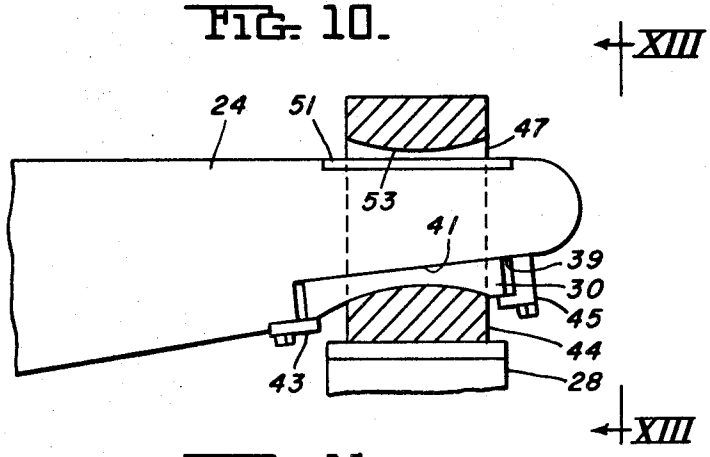
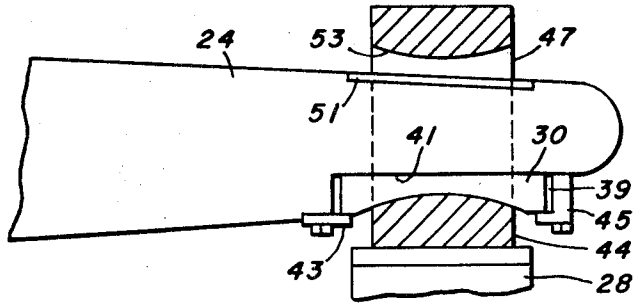


FIG. 11.



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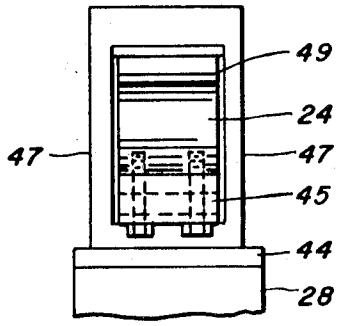

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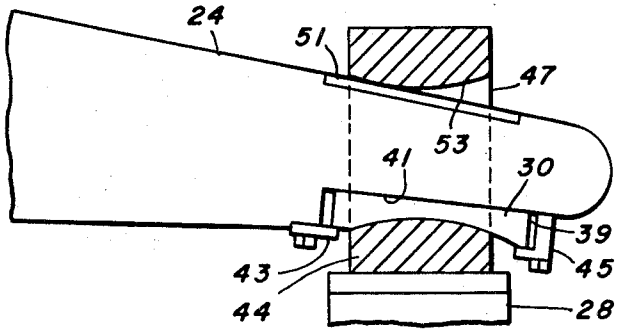


INVENTOR.
DANIEL L. LOMBARD.

By Murray & Finkhauser

Attorneys

FIG. 14.

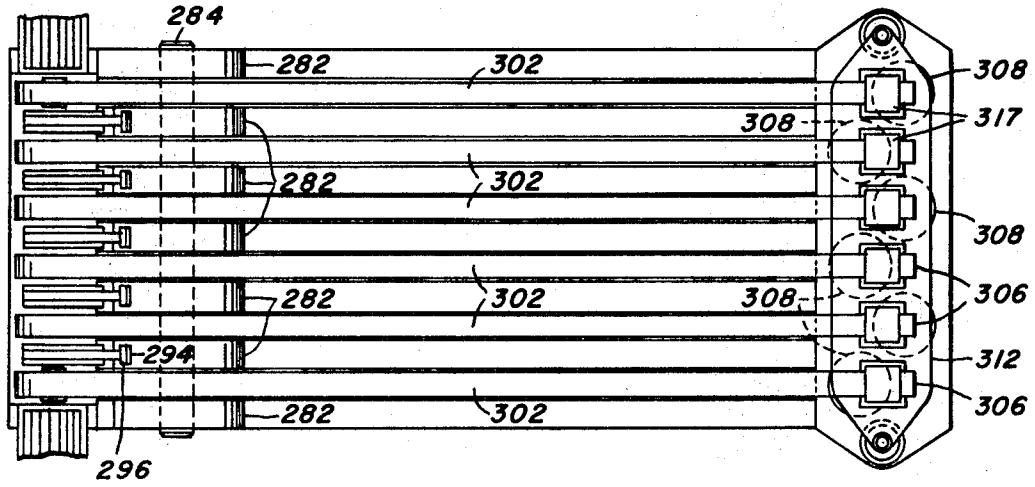
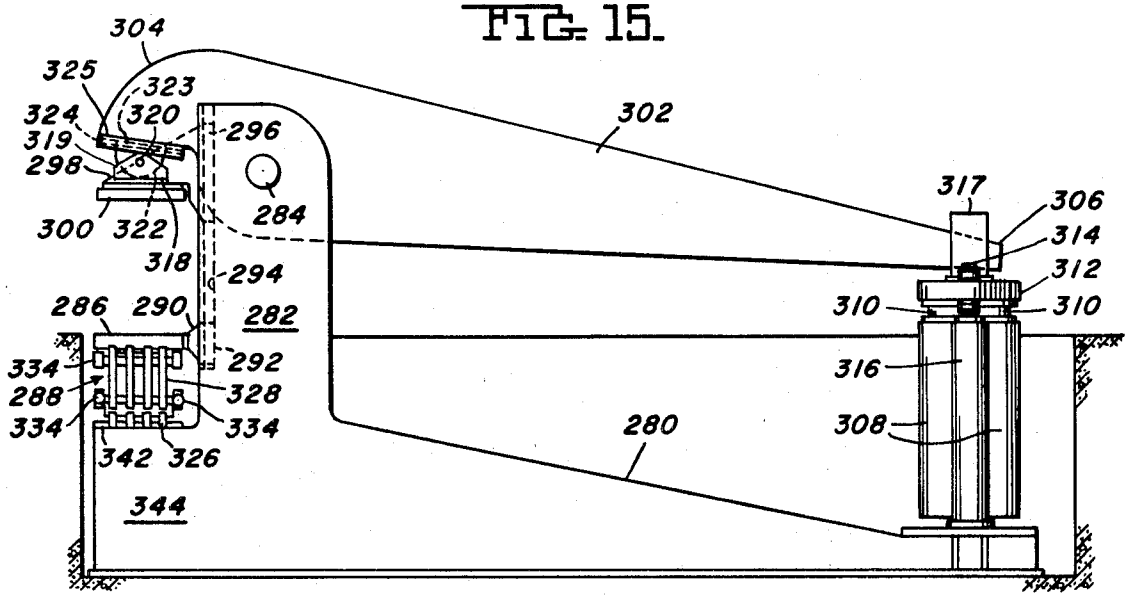
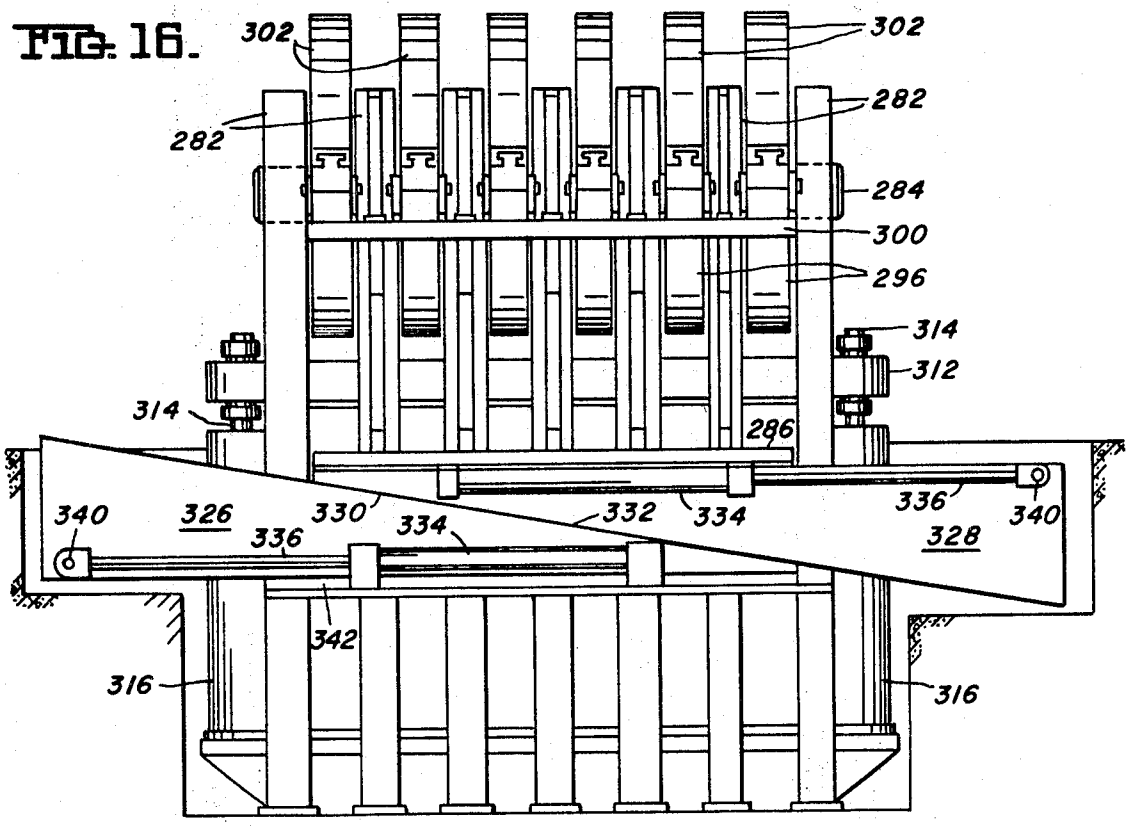


FIG. 15.



INVENTOR.
DANIEL L. LOMBARD
By
Murray & Linkhauer
Attorneys

FIG. 16.



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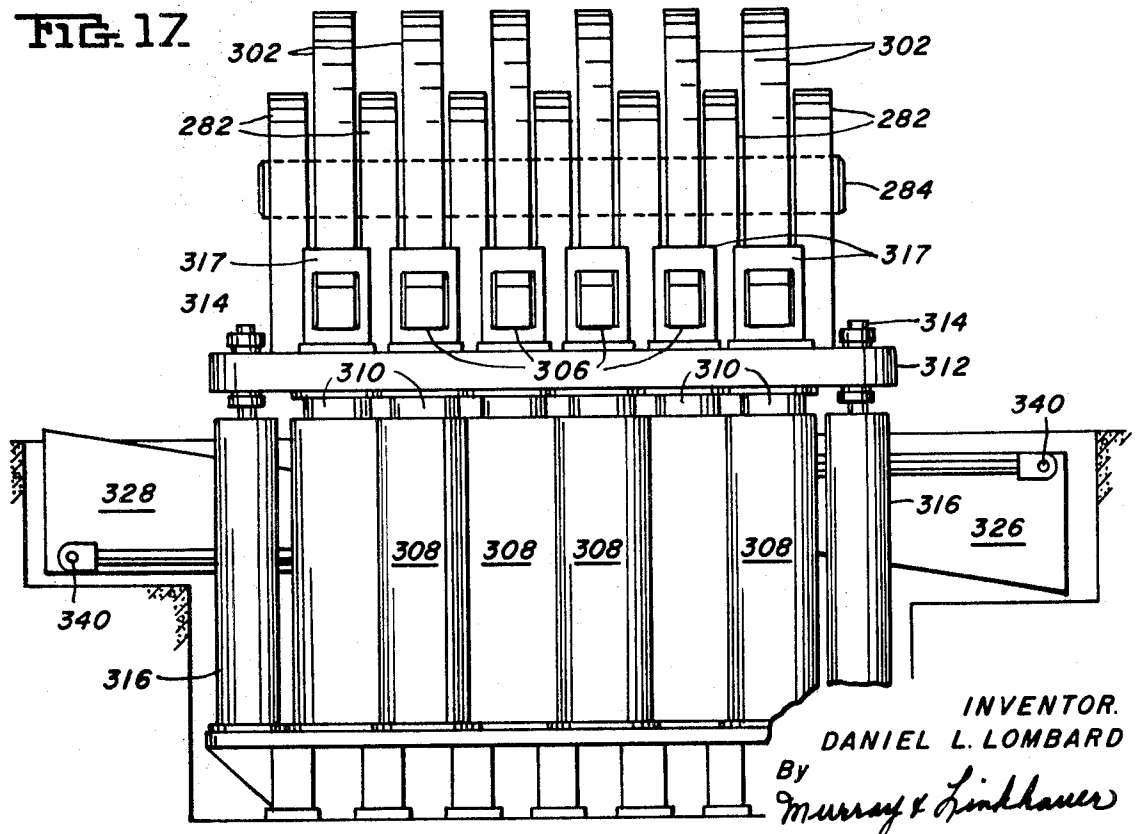
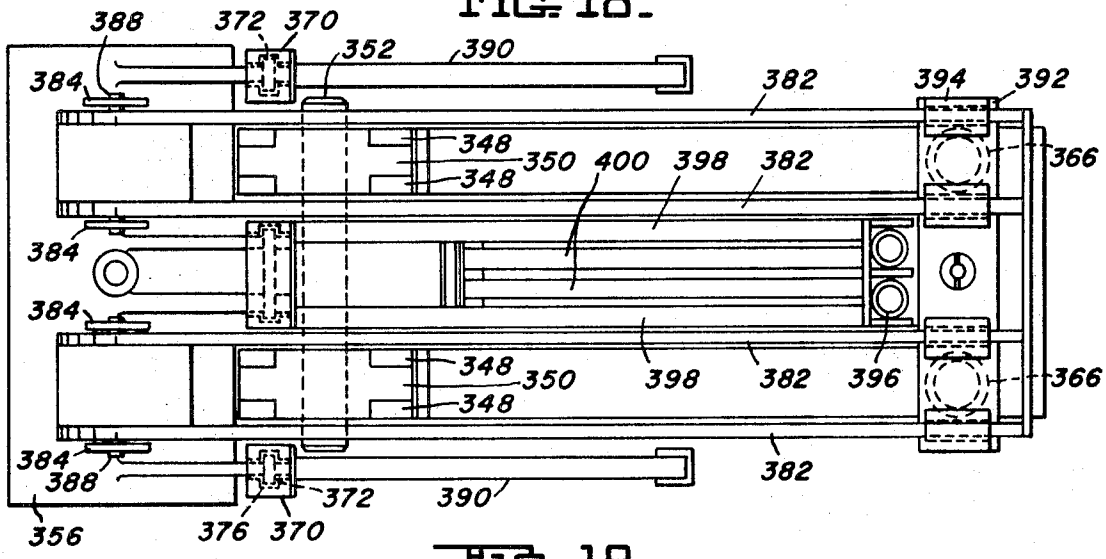


INVENTOR.
DANIEL L. LOMBARD
By Murray & Lindhauer
Attorneys

FIG. 18.



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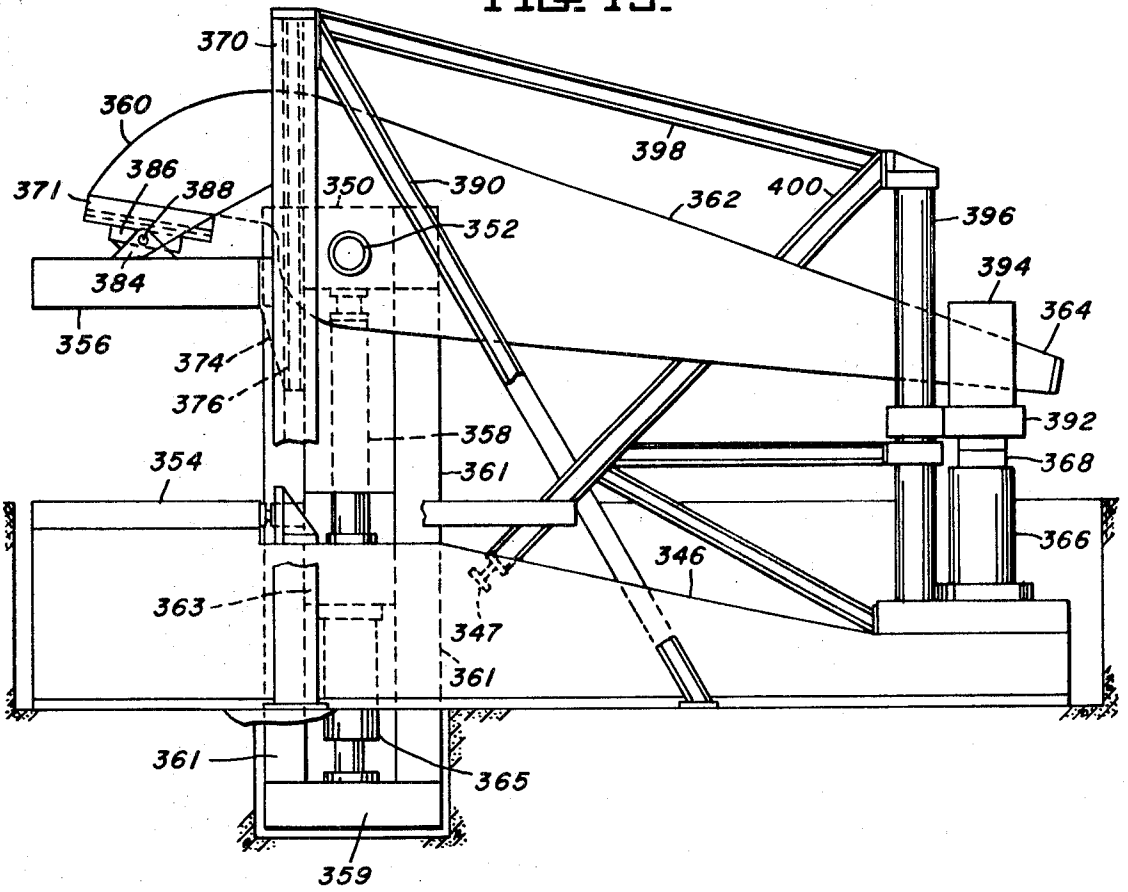


INVENTOR.
DANIEL L. LOMBARD
By Murray & Linkhauer
Attorneys

FIG. 20.

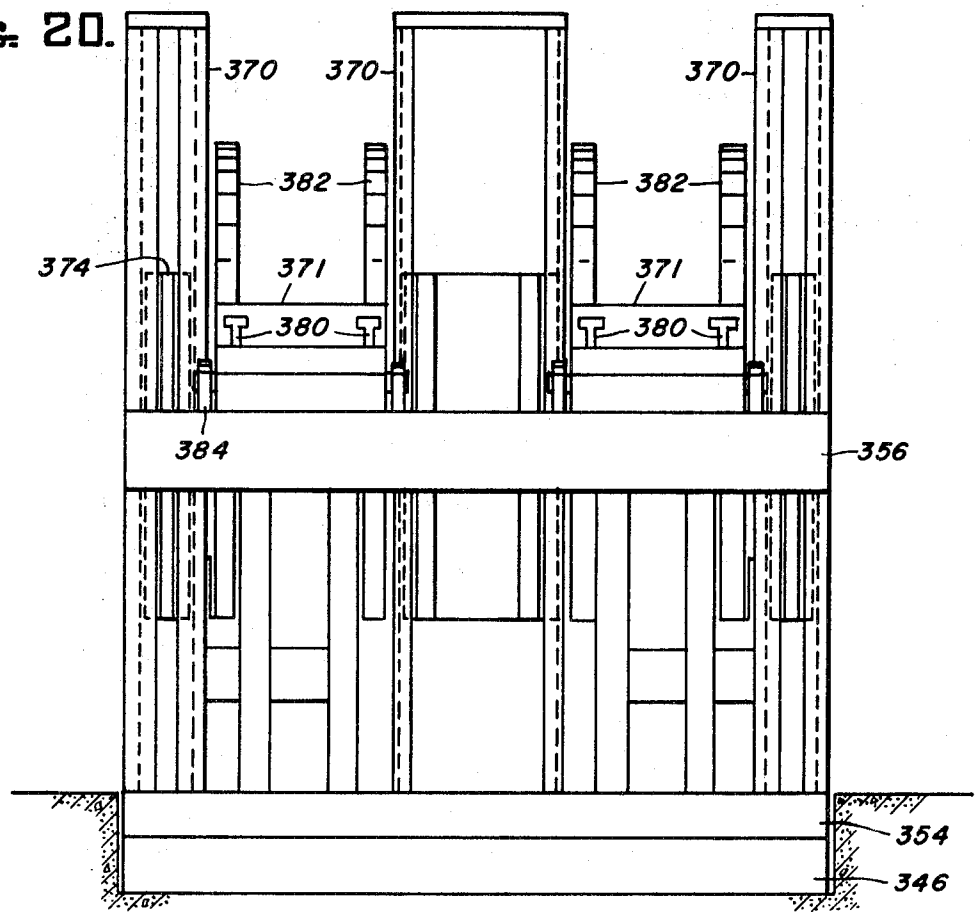
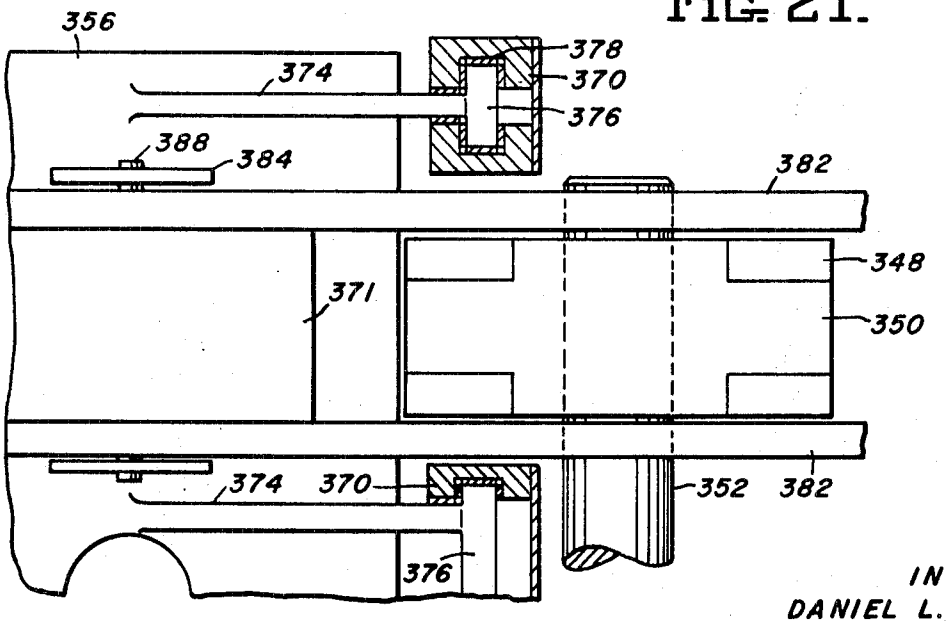


FIG. 21.



INVENTOR.
DANIEL L. LOMBARD
By
Murray & Linkhauer
Attorneys

HYDRAULIC FORGING PRESS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to the forging, extrusion or compaction of material including metals, and in particular to a power-operated press of fluid-operated or other type.

2. Background of the Invention

Metal-forming presses of various kinds are known, among which are included ones relying upon hydraulic force to urge together a pair of platens encompassing the work, alone or together with dies to operate upon it. As work comes to be done upon larger pieces and/or metals of greater strength, the total force required to be exerted by a press rises, and there is a corresponding increase in the size and weight of both the hydraulic cylinders used to exert the force and the frame or other means used to support the hydraulic cylinders in such manner that their force may be effectively applied to the work.

In recent years, with the development of exceedingly powerful jet engines, there has been a corresponding increase in the size of aircraft designed and built to be powered by such engines. Relatively little has been done, however, to increase the size of the forging presses used to shape, for example, fuselage or wing portions of such aircraft. The 50,000 ton capacity presses now available are thus limited in the area of aircraft skin and strength members that they can effectively shape in one push, yet their construction is already so massive and their cost so expensive that without a breakthrough of some sort it is virtually inconceivable that larger presses can be economically produced and used.

Distinct advantages attend the use of a press of more enormous capacity, e.g., 200,000 tons. A greater area with higher unit pressures is shaped in one push. In some instances there is avoided the need for a weld and thus the need for either using thicker-gage material to obtain adequate in-weld strength in the case of butt welding or using additional material that may be overlapped in the case of lap welding. The savings in manufacturing time that result from the use of a press of ultrahigh capacity in the building of, for example, a fleet of 300 large jetliners (which may be of the kind that earn millions of dollars a year for the airlines operating them) have been apparent to those skilled in the art, but how to make a press substantially larger than any hitherto built without incurring costs correspondingly astronomical and encountering problems difficult or impossible to solve has not been obvious to skilled designers of presses. In particular, it has not been apparent to those skilled in the art how above-indicated results could be obtained without using hydraulic equipment of unproven design and/or using unrealistic unit pressures.

It has been seriously proposed, for example, to build, at a cost of tens of millions of dollars, a direct-push hydraulic forging press of 200,000-ton capacity, using a cylinder with a 16-foot-diameter bore and walls several feet thick with multiple-wall construction or new construction of unproven design and containing a gigantic frame ten stories high. Such a press would not, moreover, have the advantage of three open sides in the work area that is obtained in accordance with a preferred embodiment of the present invention.

Although it is with reference to the construction of presses of ultrahigh capacity that the instant invention is most clearly novel and patentable, certain of the advantages of the invention attend the construction of presses of more modest size, such as ones of about 8,000-ton capacity, so that the invention in its broadest aspects is not limited to presses of ultrahigh capacity. Among the advantages so retained in somewhat smaller presses are savings in weight per ton of capacity, increased convenience afforded by three open sides to the work area, and use of hydraulic cylinders of lower thrust and correspondingly smaller size and wall thickness.

BRIEF SUMMARY OF THE INVENTION

In its broadest aspect, the invention comprises a forging press operating like a large pliers or, in a nonpreferred form, a large nutcracker. That is to say, the combination comprising the invention contains lever arms and a pivot or fulcrum, means for bearing against the work, and means for applying force to the lever arms in such a way that the force on the work is suitably multiplied by leverage action. Certain problems arise, however, in adapting the above-indicated simple concepts to the design of any press, and these problems are aggravated in the design of a press of ultrahigh capacity. For example, it is desired to have the movable platen of the press travel straight downward, but the lever arm point to which it is attached moves in a circular arc when the lever arm is moved, so that it is an additional feature of the invention to provide means for keeping the movable platen parallel to the fixed platen. Similarly, when hydraulic cylinders are used to operate the longer lever arms, the area of contact between the piston rod end and the lever arm will tend to move in a circular arc, bending the piston rod, if means are not provided for transferring power from the piston rod to the lever arm in such a way that the piston rod remains essentially straight. With presses of large capacity, the very size of the lever arms becomes a problem, one arm possibly weighing several hundred tons and being about 100 feet long, so that to cast the lever arm in one piece, or to move the lever arm once it is cast, is difficult or impossible. It is, accordingly, a further feature of the invention to provide a large press wherein the lever arms are made by assembling a number of smaller parts. Yet another feature is the provision of means for moving and locking the location of the pivot pin. By the combination of some or all of the features indicated above, there are provided novel presses having the advantages indicated above.

DESCRIPTION OF THE DRAWINGS

A complete understanding of the invention may be had from the foregoing and following description thereof, taken together with the accompanying drawings, in which:

FIG. **1** is an elevation view of a press constituting one embodiment of the invention;

FIG. **2** is a plan view of the embodiment of the invention shown in FIG. **1**;

FIG. **3** is an elevation detail view of a portion of the embodiment of the invention shown in FIG. **1**;

FIG. **4** is an elevation view, partly in section, taken on the line IV–IV of FIG. **1**;

FIG. **5** is a plan view, partly in section, taken on the line V–V of FIG. **1**;

FIG. **6** is a plan view of an alternative embodiment of the invention;

FIG. **7** is an elevation view of the alternative embodiment of the invention shown in FIG. **6**;

FIG. **8** is a view in perspective of a wedge used in the embodiment of the invention shown in FIGS. **6** and **7**;

FIG. **9** is an elevation view of a second alternative embodiment of the invention;

FIGS. **10**—**12** are elevation detail views of a portion of the embodiment of the invention shown in FIG. **1**;

FIG. **13** is a partial detail view taken on the line XIII–XIII of FIG. **10**;

FIG. **14** is a plan view of still another embodiment of the invention;

FIG. **15** is a side elevation view of the embodiment of the invention shown in FIG. **14**;

FIG. **16** is a front elevation view of the embodiment of the invention shown in FIG. **14**;

FIG. **17** is a rear elevation view of the embodiment of the invention shown in FIG. **14**;

FIG. **18** is a plan view of still another embodiment of the invention;

FIG. **19** is a side elevation view of the embodiment of the invention shown in FIG. **18**;

FIG. 20 is a front elevation view of the embodiment of the invention shown in FIG. 18; and

FIG. 21 is a detail plan view of a part of the embodiment of the invention shown in FIG. 18.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings (which it will be understood are not to scale, various parts being exaggerated or diminished in size in order to promote clarity of showing) and in particular to FIG. 1, there is shown a hydraulic extrusion or forging press having a base plate 2, upon which there is mounted a lower or fixed platen 4, a frame 6, hydraulic cylinders 8 and 10, four vertical columns 12, 12*a*, 14 and 14*a*, and brace members 16. The base plate 2 is of sufficient thickness and strength itself to support the other parts placed on it, without relying for support upon a concrete foundation or the like. The fixed platen 4 cooperates with a movable platen 18, which may be urged toward the fixed platen 4 by means of a short arm 20 of a lever arm 22, having a long arm 24 and fulcrumed about a pin 26, the rod 28 of the hydraulic cylinder 10 acting through a shoe 30 to raise the end of the arm 24 remote from the work and thereby lower the movable platen 18 toward the fixed platen 4.

The hydraulic cylinder 10 is supplied with fluid from a source 11 by means of a line 13 containing a pump 15 and a valve 17, with a line 19 being provided for the return of fluid to the source 11. Here and elsewhere throughout this specification, it will be understood that appropriate additional valve and pump means are supplied for operation of the piston of the associated hydraulic cylinder in the opposite direction, these being omitted in the interest of simplicity. Movable platen 18 is guided for motion toward and away from the fixed platen 4 by means of a pair of pins 32 riding in slots 34 in brackets 36 affixed to the movable platen 18 on either side of the short arm 20 of the lever arm 22, and further by means of tongues 38, best seen in FIG. 2, that ride in corresponding grooves 40 in the frame 6. When the lever arm 22 is moved, the pins 32 move arcuately, and means such as the slot 34 and the tongue-and-groove arrangement 38 and 40 must be provided in order to translate that arcuate movement into rectilinear vertical movement.

Similarly, the end of long lever arm 24 remote from the work also moves arcuately, and it is desirable that the piston rod 28 of the hydraulic cylinder 10 move in a straight line. Accordingly, there is provided a shoe 30 having an arcuate or spherical recess 42, which is contacted by a head 44 affixed to the piston rod 28 and having a matching surface. As best seen in FIGS. 10—13, the shoe 30 rides in a recess 39 in the underside of the end 24 of lever arm 22, moving along the surface 41 toward the fulcrum 26 as shown in FIG. 10 when the lever arm 22 is raised and away from the fulcrum 26 as shown in FIG. 12 when the lever arm 22 is lowered. Lugs 43 and 45 serve to keep the shoe 30 in place, cooperating for that purpose with side members 47 of the head member 44 secured to the piston rod 28, the side members 47 defining an opening 49 through which the end of the lever arm 24 protrudes, as best seen in FIG. 13. As also seen in FIG. 2 and in FIGS. 10—13, the upper surface of the arm 24 is provided with a wear-resistant lining 51, which makes contact with an arcuate surface 53 of the head 44 in certain instances when the piston rod 28 is being retracted.

Columns 12 and 14 are braced against motion toward or away from the work by means of brace members 16, which are affixed to the base plate 2 by a horizontal part 58 secured by a bolt 60. Brace 16, at its other end, is secured to a plate 62 that has in it openings 64, 66, 68 and 70, through which are passed the tops of the columns 12, 12*a*, 14 and 14*a*, to assure the maintenance of proper spatial relation thereamong.

Means are provided for moving the fulcrum pin 26 vertically within the frame 6 and locking the pin 26 in a desired position. As best seen in FIGS. 1 and 3, one embodiment of such means comprises a first hydraulic cylinder 8 having a piston 80 and a piston rod 82, to which hydraulic fluid is led from a source 84 by means of a line 86 having therein a valve 88 and a pump 90, fluid being returned from the cylinder 8 to the source 84 by means of a line 92; a movable block 94 arranged for movement in ways 96 provided in the frame 6 for vertical motion and adapted to support the pin 26; and a second hydraulic cylinder 98 having a piston 100 and a piston rod 102, hydraulic cylinder 98 being supplied with fluid from a source 104 by means of a line 106 containing a pump 108 and a check valve 110, hydraulic fluid being returned from the cylinder 98 to the source 104 by means of a line 112.

As will be better seen in FIG. 5, the frame 6 also has openings 114 and 116, to permit upward and downward movement of the lever arm 22. FIG. 5 also shows that the lever arm 22 is made in a number of parts 118, 120 and 122 of generally similar shape; this is especially important in the manufacture of presses of ultrahigh capacity, where it is necessary that, in order to withstand the high stresses involved, the lever arm have a weight of several hundred tons, i.e., more than can be practically cast at one time, even with an open-hearth furnace and casting pits and facilities of the largest capacity known today. Thus, it is contemplated that, if necessary, the lever arm 22 is not only made of similar parts running longitudinally thereof, such as the parts 118, 120 and 122 of FIG. 5, but is also, if necessary, made up of parts joined by full-penetration transverse welds, such as the weld 124 indicated on FIG. 1. It will be understood, moreover, that in order to make efficient use of the steel or other material comprising the lever arm 22, openings such as 126 and 128 shown in FIGS. 1 and 2 may be provided, it being apparent to those skilled in the art how the strength/weight ratio of the lever arm 22 may be improved by including in the design thereof openings such as 126 and 128 of suitable size, location, and shape. It will be further seen from FIG. 5 that means, such as flanges 130 and 132, are provided to keep the lever arm 22 located in a particular position along the fulcrum pin 26, the flanges 130 and 132 being secured to the pin or against the lever arm 22 by conventional means (not shown). Similar flanges 134 and 136, secured by setscrews 138 and 140 or other suitable means, keep the fulcrum pin 26 in position with respect to the block 94.

It will be understood that between the lever arm 22 and the fulcrum pin 26, there are provided suitable low-friction bearings (not shown).

As shown in FIG. 4, which is a view taken on the line IV–IV of FIG. 1 with the movable platen 18 removed, it will be seen how a plate 142 affixed to the piston rod 82 of the cylinder 8 bears against the block 94 to permit vertical movement of the fulcrum pin 26. FIG. 4 also shows the hydraulic cylinder 98, which by means of its piston rod 102 and a plate 144, bears upon the top of the block 94, to lock it against vertical movement during a forging operation.

In FIG. 6, there is shown in plan view, with certain parts omitted or partly broken away for clarity, a preferred embodiment of the invention, in accordance with which a number of lever arms 146 are used in place of the single lever arm 22 of the embodiment shown in FIGS. 1—5. Otherwise, the structure is generally similar to that of the embodiment of FIGS. 1—5. There is a base 148, upon which there is set a frame 150, which has recessed portions 152 and 154, within which there is guided a block 156 which supports a fulcrum pin 158, about which the lever arms 146 are pivoted. In FIG. 6, there is also shown the movable platen 160, which is joined by means of brackets 162 to projections 164 near one end of the lever arms 146. As best seen in FIG. 7, the brackets 162 have a slot 166, which serves the same purpose as the slot 34. There are also shown the grooves 168 in the frame 150, which cooperate with tongues 170 on the movable platen 160 to keep the movable platen 160 level. Braces 172, affixed to the base as at 174, support a plate 176, within which are received standards 178, which are secured to the plate 176 by nuts 180, and at their other ends, to the base 148.

As will be best understood by reference to both FIGS. 6 and 7, the ends of the lever arms 146 remote from the work are urged upwardly by means of hydraulic cylinders 182. Preferably, the cylinders 182 are supplied with fluid from a common reservoir 183 by individual lines 185 having individually controlled pumps 187 and check valves 189, there being also lines 191 for return of fluid to the reservoir 183. By means of the cylinders 182, the ends 184 of the lever arms 146 are urged upwardly to cause the movable platen 160 to move downwardly and apply force to the work between the platens 160 and 186.

As best seen in FIG. 7, the hydraulic cylinders 182 have piston rods 190 that have heads 192. For clarity, a head 192 is shown in central cross section, so that there may be seen its convex surface 194. Surface 194 matches with the concave surface 196 of a shoe 198 that rides in a space 199 along the lower surface of the lever arm 146 as defined by keeper members 200 secured to the lever arm as by bolts 201. The sliding action of the shoe 198, to maintain vertical movement of the piston rod 190 despite the arcuate movement of the lever arm 146, is substantially as hereinbefore described with reference to FIGS. 10—13. The upper surface of the lever arm 146 is preferably provided with a wear-resistant lining 202. The piston rod also has side members 203 of the kind best shown in FIG. 13, only one of which is shown in FIG. 7, and terminate in a portion 204 provided with an arcuate surface 206 that will, in certain instances when the rod 190 is being retracted, bear against the lining 202.

As best seen in FIG. 7, it is preferred with this embodiment to use, as a means for locking the position of the fulcrum pin 158 against upward travel during a forging operation, a plurality of wedge-shaped members 208. A perspective view of an individual wedge-shaped member 208 appears in FIG. 8. As best seen there, the sides of the wedge meet at an angle 210 that is less than the angle of friction between such metal surfaces, such angle of friction being about 13°. Accordingly, when a number of the wedge-shaped members 208 are inserted between the frame 150 and the block 156 that carries the pin 158, this being done with hydraulic pressure or by other suitable means, the block 156 is secured against upward movement during a forging operation, not even the slight upward movement that results from the compressibility of hydraulic fluid under the high pressures generated in equipment of this kind being encountered.

As seen in FIG. 9, in accordance with yet another aspect of the invention, a press is provided in which there are used one or more lever arms of a different kind, i.e., fulcrumed at one end and powered at the other, with the work in between. Thus, in the embodiment of the invention shown in FIG. 9, the press comprises a base 212 having set thereon a frame 214 for supporting a fulcrum pin 216 riding in a block 218 that is vertically movable by means of a hydraulic cylinder 200 and anchorable by means of a second hydraulic cylinder 222, also set on the base 212 are a fixed platen 224, standards 226, and a brace member 228 secured to the base 212 as at 230. Near the tops of the standards 226 is a plate 232, which is joined to the brace 228. Set on the base 212 amid the standards 226 is a hydraulic cylinder 234 that is provided with fluid from a source 236 by a line 238 having therein a pump 240 and a check valve 242. Fluid is returned to the source 236 via line 244.

A lever arm 246 is supported at one end by the fulcrum pin 216 and engages with a pin 247 a movable platen 248 having brackets 250 containing slots 252 to receive the pin 247. Movable platen 248 has tongues (not shown) that cause it to ride vertically in grooves 254 in the frame 214.

Cylinder 234 moves platen 248 to apply force to the work by moving piston rod 256 downwardly and causing its head 258, having a convex surface 260, to bear against the concave surface 262 of the shoe 264. The structure and operation are in general the same as shown in FIGS. 10—13, except that the head 258 is located above the lever arm 246, so that it is the upper surface of the lever arm 246 that is provided with keeper members 266 secured to the lever arm 246 by means of bolts 268, and it is the lower surface of the lever arm that is provided with a wear-resistant lining 270 for contact with the convexly curved surface 272 of the head 258 when the lever arm 246 is being raised, instead of lowered. The head 258 is shown as secured to the piston rod 256 by bolts 274.

It will be understood that a plurality of lever arms 246 and hydraulic cylinders 234 may be used in order to obtain greater force and a platen 248 of greater working area.

Referring now to FIGS. 14—17, there is shown another embodiment of the present invention, comprising a press of ultrahigh capacity. The press there shown comprises a base member 280, best seen in FIG. 15, with which are joined several vertical members 282, which receive a pin 284. It will be seen that in this embodiment of the invention, the pivot pin 284 is not moved; rather, it remains stationary, and adjustment is made for the use of the press with workpieces of different heights by providing for the vertical movement of both platens. That is to say, the press further comprises a lower platen 286 which is moved vertically by a sliding-wedge arrangement 288 to be hereinafter more fully described. As best seen in FIG. 15, the lower platen 286 has associated with it a plurality of web members 290 having tongues 292 that ride in grooves 294 in the member 282, to insure vertical movement of the movable lower platen 286. The grooves 294 are carried to the top of the members 282, in order that they may cooperate with similar tongues 296 associated with webs 298, in order to maintain vertical alignment of the movable upper platen 300.

Movable upper platen 300 is moved by a plurality of lever arms 302 comprising a short end 304 on the same side of the pin 284 as the work and a substantially longer end 306 on the opposite side of the pin 284 from the work and adapted to be moved upwardly through the action of a plurality of hydraulic cylinders 308. The centers of the piston rods 310 of the cylinders 308 lie on the centerlines of the lever arms 302, and as best seen in FIG. 14, the cylinders 308 are arranged in a staggered relationship if the design requires cylinders 308 of such diameter that a straight-line arrangement is not possible. A plate 312 serves to keep the actions of the piston rods 310 synchronized. The plate 312 is connected at its ends to rods 314 of cylinders 316. Secured to the plate 312 are brackets 317, within which are received the ends 306 of the lever arms 302. Though this is not shown in the drawings, the brackets 317 act upon the ends 306 of the lever arms 302 in the manner indicated in FIGS. 10—14, inclusive.

The connection between the end 304 and the movable platen 300 is made by providing an internally concave seat member 318 having upwardly projecting lugs 319 that have aligned openings, through which there may be passed a pin 320, by means of which the seat member 318 is joined to a convex shoe member 322, which has a tongue 323 that rides in a groove 324 of a plate 325 affixed to the end 304 of the lever arm 302. Thus, as the end 304 moves up and down, the tongue 323 slides in or out along the groove 324, so that the motion of the platen 300 remains rectilinear despite arcuate motion of the end 304 of the lever arm 302.

It remains to describe the sliding-wedge arrangement 288 for causing vertical movement of the movable lower platen 286. This comprises a pair of wedge members 326 and 328 having long inclined surfaces 330 and 332 in contact with each other, the wedge members 326 and 328 being movable by means of a plurality of cylinders 334 and their associated piston rods 336, which are connected to the wedge-shaped members as at 340, between a retracted position in which the vertical position of the movable lower platen 286 is high and an extended position, in which the vertical position of the movable lower platen 286 is low. The lower wedge member 326 rides upon a suitable support 342 carried upon a generally horizontal part 344 of the base 280.

Referring now to FIGS. 18, 19, 20 and 21, there is shown still another embodiment of the invention, comprising a hydraulic forging press of more modest capacity than that

shown in FIGS. 14—17. The press there shown comprises a pair of base members 346, one of which is seen in FIG. 19, these being joined by a transverse brace or spacer member 347, best seen in FIG. 19. Rising from the base members 346 are vertical members 348 which serve as guides for blocks 350, which receive the pivot pin 352. The work is placed between a lower platen 354, which may be made horizontally movable for certain purposes (as will be understood by those skilled in the art), and a vertically movable upper platen 356. The block 350 is moved vertically to a desired position, depending upon the height of the work, by means of pin-positioning cylinders 358.

As seen in FIG. 19, means are also provided to lock the pin 352 and blocks 350 against upward motion while the platen 356 is pushing downward on the work. To that end, I provide a second set of blocks 359, which are joined to the blocks 350 by vertical members 361, which are provided with suitable guides (not shown). Associated with the base members 346 are a pair of fixed members 363, upon the tops of which the pivot-pin-positioning cylinders 358 bear and upon the bottoms of which locking cylinders 365 bear. The pivot pin 352 is thus brought into position by operating the cylinders 358 to move the frame structure comprising the blocks 350 and 359 and the vertical members 361 as a unit, upward or downward to the desired position of the pin 352, and then the pivot pin 352 is locked in that position by operation of the cylinders 365, which exert downward force on the above-mentioned frame structure to oppose the upward force that results when the platen 356 comes into contact with the work. During operation of the cylinders 358, the cylinders 365 were, of course, either completely retracted or free to retract to the extent necessary to permit the cylinders 358 to operate as desired. Though the pivot pin blocks 350 may, in some instances, be positioned with the use of a single set of double-acting hydraulic cylinders, it is certainly preferred, in constructing a press of large capacity, to use the frame structures and locking cylinders as indicated above, as it will be possible in this way better to distribute the large stresses exerted by the lever arms 302 on the pin 352 and blocks 350 when the platen 354 comes into contact with the work. If a single set of double-acting cylinders is used, these stresses might need to be taken by bolts securing its piston rods to the blocks 350; the use of the frame structure and locking cylinders 365 avoids this.

Means are provided to insure vertical motion of the upper platen 356, despite the arcuate motion of the ends 360 of the lever arms 362 when, as will be explained below, the long ends 364 of the lever arms 362 are urged upwardly by means of hydraulic rams 366 having piston rods 368. These means comprise guide columns 370 and the grooved plates 372. The guide columns 370 are provided with a groove 372, best seen in FIGS. 18 and 21, and the movable upper platen has webs 374 that terminate in tongues 376 that ride in the grooves 372 in the guide columns 370. Grooves 372 are provided with wear plates 378, as shown in FIG. 21.

As best seen in FIGS. 19 and 20, allowance is also made for arcuate motion of the ends 360 of the lever arms 362 by providing a plate 371 having therein grooves 380, for a purpose hereinafter explained. As can be seen from FIGS. 18 and 20, the lever arms 362 comprise members 382 which straddle the members 348 and to which the grooved plate 371 is joined. The movable platen 356 has brackets 384, by means of which the movable platen 356 is joined to a movable member 386 by means of a pin 388. As best seen in FIG. 20, the movable member 386 is provided with tongues which ride in the grooves 380 of the grooved plate 371. The motion is as explained above with reference to FIG. 15 and the parts 318 to 325.

The exterior guide columns 370 are provided with braces 390. The bracing of the interior guide column 370 will be described hereinbelow.

Turning now to the right-hand of the machine as seen in FIGS. 18 and 19, it will be seen that power for moving the lever arms 362 is provided by means of a pair of power cylinders 366 having a piston rod 368 which bears upon a plate 392, above which and joined to which are provided a plurality of brackets 394, which are similar in construction to the brackets 316 described hereinabove. Also rising from the base are a number of crosshead guide columns 396, which fit through openings in the plate 392 and aid in insuring vertical travel of the piston rod 368.

Brace members 398 join the tops of the crosshead guide columns 396 to the interior guide column 370, and additional brace members 400 connect the tops of the crosshead guide columns with the brace members 347.

With this invention, it is preferred that the distance between the applied force and the fulcrum pin be about 3 to 20 times the distance between the fulcrum pin and the work, to obtain a corresponding multiplication of the applied force. While the applied force has been shown as being generated by means of one or more hydraulic cylinders, it will be apparent to those skilled in the art that such other means as screws, dead-weight loading, winches and the like may be used.

While I have shown and described herein certain embodiments of my invention, I intend to cover any change or modification therein which may be made without departing from the spirit and scope of the invention.

I claim:

1. A press comprising, in combination, first and second platen means for contacting a workpiece, at least one of said means being movable toward and away from the other of said means; a force-applying means comprising a hydraulic cylinder having a vertically reciprocable piston therein; lever arm means having fulcrum means, said lever arm means being connected to a movable one of said platen means through a sliding connection permitting relative horizontal movement between said movable platen means and said lever arm means such that said platen means moves rectilinearly despite arcuate motion of the part of said lever arm means in contact with said platen means; and a sliding shoe device connecting said lever arm means inside a bracket connected to said vertically reciprocable piston at a location substantially more remote from said fulcrum means than is said part of said lever arm means in contact with said platen means.

2. A press as defined in claim 1, characterized in that said lever arm means comprises a plurality of lever arms, each of said lever arms being about 70 feet or greater in length and about 250 tons or greater in weight, each of said lever arms being comprised of a plurality of pieces of substantially lighter weight.

3. A press as defined in claim 1, characterized in that said fulcrum means is located between said movable platen means and said force-applying means.

4. A press as defined in claim 1, characterized in that said press has means for moving said fulcrum means rectilinearly in a path parallel to the travel of said movable platen means and for securing said fulcrum means in a chosen position.

5. A press as defined in claim 4, further characterized in that said means for securing said fulcrum means in a chosen position comprises a plurality of wedges having generally flat surfaces of substantial area disposed with respect to each other at an angle less than the angle of friction.

6. A press as defined in claim 1, characterized in that said fulcrum means has a fixed location and including means for moving one of said platen means other than said platen means connected to said lever arm means in a rectilinear path toward and away from said platen means connected to said lever arm means.

7. A press as defined in claim 1, characterized in that said fulcrum means comprises a pin about which said lever arm means can rotate and including first block means in which said pin is journaled, first hydraulic cylinder means interposed between the lower surface of said first block means and an upper surface of a stationary support, vertical guide means extending downwardly from said first block means, second block means secured to the bottom of the vertical guide means, and second hydraulic cylinder means interposed between the top

surface of said second block means and the underside of said stationary support, said first hydraulic cylinder means serving to elevate or lower said pin and said second hydraulic cylinder means serving to lock said first and second block means, said vertically extending guideways and said pin in a fixed location.